VERIFIED TRANSLATION

I, Adorno Silvano c/o Società Italiana Brevetti S.p.A., Via Carducci 8, 20123 Milano Italy, hereby declare that I am conversant with the Italian and the English languages and that I am the translator of the document attached and certify that to the best of my knowledge and belief the following is a true and correct English translation of Italian Patent Application No. MI2001A 002389 filed on November 12, 2001 in the name of SAES GETTERS S.p.A.

Translator's signature:

Dated: November 21, 2006

MINISTRY OF PRODUCTIVE ACTIVITIES

General Directorate for Productive Development and Competitivity

Italian Patent And Trademark Office

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Authentication of a copy of documents relating to a patent application for *Industrial Invention*

No. MI2001A 002389

It is hereby declared that the attached is the true copy of the original documents filed together with the above-mentioned patent application, the data of which result from the enclosed filing record.

Record filed with the Milan Chamber of Commerce n. MIR003974 of 20/12/2001 (page 1) concerning the filing of formal drawings (pages 3).

Rome, 25 October 2002

THE DIRECTOR

Mrs. E. MARINELLI

OIPE DEC 27 2006 PATENT & TRADEMARK OFFICE

TO THE MINISTRY OF INDUSTRY COMMERCE AND HANDICRAFT — FORM A — STAMP

ITALIAN PATENTS AND TRADEMARKS OFFICE - ROME

Patent Application for Industrial Invention, Filing Reserves, Advanced Accessibility to Public

A. APPLICANT(S) — Type

1) Name | SAES GETTERS S.p.A. | SP |

Residence | LAINATE (MI) | code | 00774910152 |

2) Name | |

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C. ELECTED DOMICILE | see above |

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D. TITLE proposed IPC (sect./class/subcl.) | | group/subgroup | |

|"HOLLOW CATHODE WITH INTEGRATED GETTER FOR DISCHARGE LAMPS AND METHODS FOR THE REALIZATION THEREOF" |

Advanced Accessibility to Public: yes | | no |X| in case of petition: date | | File n. | |

E. DESIGNATED INVENTORS Surname Name — Surname Name

1) | GALLITOGNOTTA Alessandro | 3) | CORAZZA Alessio |

2) | BOFFITO Claudio | 4) | |

F. PRIORITIES

State or organization	priority type	appln. n.	filing date	encl.y/r	RESERVES RESOLUTION date	file n.
1)						
2)						

G. RECOGNIZED CENTER FOR DEPOSITING MICRO-ORGANISM COLTURES, name | |

H. SPECIAL REMARKS

| |

ENCLOSED DOCUMENTS

	n. copies				RESERVES RESOLUTION date	file n.
doc. 1)	2	prov	pages 11	abstract, main drawing, specif., claims (1 copy comp.) ...		
doc. 2)	2	~~prov~~	sheets 03	drawing, (compulsory if cited in specification, 1 copy).....		
doc. 3)	1	res		power of attorney ~~or reference to general power~~		
doc. 4)	0	res		designation of inventor...		
doc. 5)	0	res		priority documents with Italian translation.......................	see priorities	
doc. 6)	0	res		authorization or assignment deed................................		
doc. 7)	0			complete name of applicant		

8) payment certificates, total lire | THREEHUNDREDSIXTYFIVETHOUSAND | compulsory

FILLED ON | 12/11/2001 | SIGNATURE OF APPLICANT(S) | AGENT: Ing. Silvano ADORNO No.178 BM |

CONTINUES YES/NO | NO | | |

CERTIFIED COPY OF THE PRESENT ACT IS REQUESTED YES/NO | YES |

CHAMBER OF COMMERCE INDUSTRY HANDICRAFT AND AGRICULTURE OF | MILANO | code | 15 |

FILING CERTIFICATE APPLICATION NUMBER | MI2001A 002389 | Reg.A

On year TWO THOUSAND ONE | day | TWELVE | month | NOVEMBER |

The above-identified applicant(s) has(have) submitted to the undersigned this application with | 00 | additional sheets for the grant of the above-mentioned patent.

I. VARIOUS REMARKS OF DRAFTING OFFICER | |

ON BEHALF OF APPLICANT — office seal — DRAFTING OFFICER

ABSTRACT OF THE INVENTION WITH MAIN DRAWING, DESCRIPTION AND CLAIMS

APPLICATION NUMBER	MI2001A 002389	REG.A	FILING DATE	12 / 11 / 2001
PATENT NUMBER			GRANTING DATE	/ /

D. TITLE
"HOLLOW CATHODE WITH INTEGRATED GETTER FOR DISCHARGE LAMPS AND METHODS FOR THE REALIZATION THEREOF"

L. ABSTRACT

A hollow cathode (20; 30; 40) having at least a portion of the inner, outer or both surfaces coated with a layer of a getter material (21; 31; 41; 41') is described. Some methods for the production of the hollow cathode of the invention are also described.

M. DRAWING

DESCRIPTION of the industrial invention entitled:

"HOLLOW CATHODE WITH INTEGRATED GETTER FOR DISCHARGE LAMPS AND METHODS FOR THE REALIZATION THEREOF"

in the name of the Italian firm SAES GETTERS S.p.A., having its seat at Lainate (MI)

The present invention relates to a hollow cathode with integrated getter for discharge lamps, and to some methods for the realization thereof.

There are defined as discharge lamps all the lamps in which the emission of a radiation, that can be visible or ultraviolet, takes place as a consequence of the electric discharge in a gaseous medium. The discharge is triggered and sustained by the potential difference applied to two electrodes placed at the opposed ends of the lamp.

The cathodes for lamps can have various shapes, for example filaments or spiral wound filaments, or other shapes. A particularly advantageous cathode form is the hollow one: the hollow cathodes have generally the shape of a hollow cylinder which is open at the end facing the discharge zone, and closed at the opposite end. As it is well known in the field, a first advantage given by the hollow cathodes with respect to other cathode shapes is a lower potential difference (of about 5-10%) required to "light" the discharge; another advantage is a lower intensity of the "sputtering" phenomenon by the cathode, namely the emission of atoms or ions from the cathodic material that can deposit on adjacent parts, among which the glass walls of the lamp, thus reducing the brilliancy thereof. Examples of lamps with hollow cathodes are described for instance in patents US 4,437,038, 4,461,970, 4,578,618, 4,698,550, 4,833,366 and 4,885,504 as well as in the published Japan patent application 2000-133201.

In this field it is also known that, in order to assure a proper operation of a lamp throughout its life, it is necessary to assure the composition consistency of the mixtures forming the gaseous medium of the discharge. These mixtures are in general mainly formed by one or several rare gases, such as argon or neon, and in the majority of cases some milligrams of mercury. The composition of these mixtures can vary from the desired one, both because of the impurities remained in the lamp at the production process, and of those released during time by the same materials forming the lamp or permeating inward from the walls thereof. Impurities present in these mixtures can

damage in various manners the working of the lamp: for example, oxygen or oxygenated species can react with mercury to form HgO, thus removing the metal from its function, while hydrogen can cause discharge striking difficulties (and consequently lighting difficulties of the lamp) or change the operating electrical parameters of the lamp, increasing its energy consumption.

In order to eliminate these impurities it is known to introduce in the lamps a getter material. Getter materials have the function of fixing through a chemical reaction the impurities, thus removing them from the gaseous medium. Getter materials widely used to this purpose are for example the zirconium-aluminum alloys described in patent US 3,203,901; the zirconium-iron alloys described in patent US 4,306,887; the zirconium-vanadium-iron alloys described in patent US 4,312,669; and the zirconium-cobalt-misch metal alloy described in patent US 5,961,750 (misch metal is a mixture of rare earth metals).These materials are generally introduced in the lamps in the form of getter devices formed by powders of material that are fixed to a support. Usually, getter devices for lamps are formed by a cut down size of a supporting metal strip, flat or variously folded, onto which the powder is fixed by rolling; an example of getter device for lamps is described in patent US 5,825,127.

As it is known, although in some cases the getter device is formed by a material pill simply inserted into the lamp, it is a great deal preferable when it is fixed to some constituting element of the lamp: the reasons are that a not fixed getter does not lie generally in the hot areas of the lamp, and so its gas absorbing efficiency decreases, and further it can interfere with the light emission. The device is accordingly almost always fixed (in general by spot welding), for instance to the cathodic support, whereas in some cases a suitable support is added to the lamp: in all cases, however, additional steps are required in the production process of the lamp. In addition, there are lamps having an extremely reduced diameter, such as those used for backlighting the liquid crystal screens, which have diameters not larger than 2-3 millimeters; in this case it is difficult to find a suitable arrangement of the getter device within the lamp, and the assembling operations for the device may become extremely difficult.

An object of the present invention is to provide a hollow cathode for discharge lamps, which cathode fulfils the gettering function thus overcoming the above named

problems.

This object is reached according to the present invention, that in a first aspect relates to a hollow cathode formed by a hollow cylindrical part open at a first end and closed at the opposed end, in which on at least an outer or inner portion of the cylindrical surface a layer of getter material is present.

The invention will be described below with reference to the drawings wherein:

- Fig. 1 shows the section of the end part of a discharge lamp having a hollow cathode not coated with getter material;

- Figs. 2 to 4 show the sections of various possible embodiments of the hollow cathode according to the invention; and

- Fig. 5 shows a mode for obtaining a hollow cathode according to the invention.

Figure 1 shows a section of the end part of a lamp 10 containing a hollow cathode 11 represented in its most general shape and without any coating formed of a getter layer. The cathode is made of metal and is formed by a cylindrical hollow part 12 having a closed end 13 and an open end 14. At end 13 there is fixed a part 15 formed in general by a metallic wire; this part is generally fixed to the closed end of lamp 16, for example by inserting it in the glass when this is let soften by heat to allow the sealing of part 16. Part 15 fulfils the double function of a support of part 12 and of an electric conductor for connecting part 12 to the outside power. Parts 12 and 15 may be made enbloc, but more generally they are two parts fixed to each other for example by heat seal or mechanically by compression of part 12 around part 15.

Figures 2 to 4 show different embodiments of inventive cathodes, namely having a part of the surface coated with a getter layer. In particular figure 2 shows a hollow cathode 20 wherein a getter layer 21 is only present on a part of outer surface of part 12; figure 3 shows a hollow cathode 30 wherein a getter layer 31 is only present on inner surface of part 12; finally, figure 4 shows a hollow cathode 40 wherein a double getter layer 41, 41' is present both on a portion of outer surface and on a portion of inner surface of part 12. As it will be obvious to the skilled people, although in the figures only some embodiments have been represented, the coatings of the two surfaces (inner and outer) of part 12 with a getter material can be total or partial: for example, in the case of figure 2, the layer 21 could totally coat the outer surface of part 12, or in the

case of figure 4, a partial coating of inner surface, and total coating of outer surface, or any other combination of coatings could occur.

Part 12 is made in general of nickel or, according to the teaching of Japan patent application 2000-133201, it can be formed with high melting metals such as tantalum, molybdenum or niobium, that show a reduced sputtering phenomenon.

The getter layer can be made of any one of the metals that are known to have a high reactivity with gases, which metals essentially are titanium, vanadium yttrium, zirconium, niobium, hafnium and tantalum; among these the use of titanium and zirconium is preferred. As an alternative, it is possible to employ a getter alloy, in general an alloy based on zirconium or titanium with one or more elements selected among the transition metals and aluminum, such as for instance the alloys of previously named patents.

The layer of getter material can have a thickness comprised between few microns (μm) and some hundreds of μm, according to the technique used to produce it (as specified below) and according to the diameter of part 12: in the case of hollow cathodes in which part 12 has a diameter of about 1 millimeter, it is preferable that the thickness of the getter layer is as small as possible, in so far as the getter material is enough to effectively fulfil the function of absorbing the gaseous impurities.

The layer of getter material does not alter the functionality of the cathode, as it was observed that these materials have work function values not exceeding those of the metals employed to produce part 12, and consequently the electronic emissive power of the cathode does not become reduced.

In a second aspect, the invention relates to some methods for producing cathodes with a layer of getter material.

According to a first embodiment, the layer of getter material can be produced by cathodic deposition, a technique better known in the field of thin layers production under the English term "sputtering". As it is known, in this technique the support to be coated (in this case a hollow cathode) and a generally cylindrical body named "target", made of the material intended to form the layer, are placed in a suitable chamber; the chamber is evacuated and then a rare gas, usually argon, is introduced at a pressure of about 10^{-2}-10^{-3} mbar; by applying a potential difference between the support and the

target (the latter being kept at the cathodic potential) a plasma in argon is produced with formation of Ar^+ ions which are accelerated by the electric field towards the target, thus eroding it by impact; the particles removed from the target (ions, atoms or "clusters" of atoms) deposit on the available surfaces, among which the ones of the support, forming a thin layer; for further details about principles and conditions of use, reference is made to the very abundant sectorial literature. The obtaining of a getter layer formed by a single metal, for example titanium or zirconium, can be achieved with standard technical procedures. The production of alloy layers with this technique may become complicated owing to the difficulties encountered in producing a target of getter material, difficulties that can be overcome by having recourse to the targets described in international patent application PCT/IT01/00316 in the name of the applicant. The productivity of the sputtering technique in terms of layer thickness deposited in the time unit is not particularly high, so that this technique may become preferable when getter layers no more than about 20 μm thick are to be produced, and accordingly in the case of hollow cathodes with narrow diameter. Partial coatings of surfaces of part 12 can be obtained in this case by having recourse to masking, for instance by using, during the deposition, supporting elements of part 12 that are suitably shaped and such as to selectively cover a portion of the surface thereof. An application example of such a measure is given in figure 5 regarding the production of a hollow cathode of type 40: in this case, during the deposition, part 12 is supported by an element 50 which masks a portion of both cylindrical surfaces (inner and outer) of said part; in the figure the arrows indicate the coming direction of the particles of material to be deposited; at the end of deposition, the region free of deposited getter is used for its fixing to part 15, whereas the region coated with getter is the one facing the lamp zone wherein the discharge occurs.

Another method for the production of a cathode coated with a getter layer according to the invention is by electrophoretic way; the production principles of layers of getter material by this way are exposed in patent US 5,242,559 in the name of the applicant. In this case, as known, a suspension of fine particles of getter material in a liquid is prepared, and the support to be coated (part 12) is dipped in the suspension; by suitably applying a potential difference between the support to be coated and a

subsidiary electrode (it also dipped obviously in the suspension), a transport of particles of getter material towards the support occurs; the so obtained deposit is then stiffened through heat treatments. In this case the partial or complete coating of part 12 can be obtained by simply partially or totally dipping said part in the suspension; in this case too it is further possible to selectively coat one of the two surfaces, inner or outer, by using a proper support of part 12, similarly to what previously explained in the case of element 50. This technique is fit to the production of thicker getter layers than those obtained by sputtering, with the possibility of easily and quickly forming layers having thickness up to some hundreds of µm.

Finally, when part 12 is formed of a high melting metal such as described in Japan application 2000-133201, the coating can be carried out by simply dipping the assembly in a molten bath with a composition corresponding to that of the getter metal or alloy to be deposited; as a matter of fact, titanium and zirconium melt respectively at about 1650 and 1850 °C, and all previously cited zirconium-based alloys melt below 1500 °C, whereas molybdenum melts at about 2600 °C, niobium melts at about 2470 °C and tantalum at about 3000 °C, and it is thus possible to dip, without any change, parts made of these metals in molten baths of getter metals or alloys. In this case too, by totally or partially dipping part 12 in the bath, a partial or complete coating with the getter layer is obtained.

CLAIMS

1. A hollow cathode (20; 30; 40) formed by a cylindrical hollow part (12) closed at a first end (13) and open at the opposed end (14) in which on at least an outer or inner portion of the cylindrical surface a layer of getter material (21; 31; 41; 41') is present.
2. Hollow cathode according to claim 1, wherein said cylindrical hollow part is made of metal.
3. Hollow cathode according to claim 2, wherein said metal is chosen among nickel, molybdenum, tantalum or niobium.
4. Hollow cathode according to claim 1, wherein said layer of getter material is formed of a metal selected among titanium, vanadium, yttrium, zirconium, niobium, hafnium and tantalum or of an alloy based on zirconium or titanium with one or more elements selected among transition metals and aluminum.
5. A method for the production of a hollow cathode according to claim 1, wherein the layer of getter material is formed by cathodic deposition.
6. Method according to claim 5, wherein said layer of getter material has a thickness lower than 20 μm.
7. Method according to claim 5, wherein the partial coating of one or both inner and outer surfaces of said cylindrical hollow part occurs by masking said part during the cathodic deposition with a suitably shaped supporting element (50).
8. A method for the production of a hollow cathode according to claim 1, wherein said layer of getter material is formed by electrophoretic deposition.
9. Method according to claim 8, wherein the partial coating of one or both inner and outer surfaces of said cylindrical hollow part occurs by partially dipping said part in a liquid suspension containing getter particles used for the deposition.
10. A method for the production of a hollow cathode according to claim 3, wherein said cylindrical hollow part is made of tantalum, molybdenum or niobium, and the layer of getter material is formed by dipping said part in a molten bath of the getter metal or alloy of which the layer is to be made.
11. Method according to claim 10, wherein the partial coating of one or both inner and outer surfaces of said cylindrical hollow part occurs by partially dipping said

part in said molten bath.

MINISTRY OF INDUSTRY, COMMERCE AND HANDICRAFT

PROVINCIAL OFFICE OF INDUSTRY COMMERCE and HANDICRAFT of MILAN

Patent Department

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DEC 27 2006
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Following up documents - Reg.R

Date of filing	File number of the following up	Applicant
20.12.2001	BREV. MI – R 003974	SAES GETTERS S.p.A.

Applicant's representative
Società Italiana Brevetti S.p.A.
Via Carducci, 8
20123 MILANO

Ref. application no.	filing date of the application
MI2001A 002389	12 NOVEMBER 2001

invention	X
model:	
trade mark	

	Object of the following up
1	No. 3 SHEETS OF FORMAL DRAWINGS IN DUPLICATE
2	
3	
4	
5	
6	
7	
8	

On behalf of applicant	Drafting officer